REEF LIGHT INSPECTION
CARYSFORT REEF LIGHT

UNITED STATES COAST GUARD
OFFSHORE KEY LARGO, FLORIDA

USCG Task Order No.: HSCG82-10-J-PMV228
Contract No.: HSCGG1-10-D-PRV090

September 2010

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TABLE OF CONTENTS

1.0 EXECUTIVE SUMMARY

This report presents the findings from a reef light inspection completed for the Carysfort Reef Light Offshore Key Largo, Florida. The assessment included interior and exterior structural inspections, development of repair recommendations, and estimated repair costs of the reef light.

In general the reef light is in fair condition with areas of coating loss and corrosion on the structural framing and all exterior surfaces. The lantern room catwalk has advanced deterioration which is a safety hazard. The stairwell cylinder steel plates have multiple cracks near the top; however, most have been reinforced with supplemental steel plates. The interior of the dwelling has moderate deterioration. All electrical and utility systems are in operable. Cathodic protection anode brackets are lying on the channel bottom near Column 9; no anodes are present.

In general the reef light is in fair condition with localized areas of corrosion on the framing members, floor plates, wall panels, observation decks, and stairs as well as loss of section up to 100% on knee braces, bolt connections, stairwell connections, and the deck. Light to heavy scaling was observed on all uncoated steel members. Currently these defects do not significantly reduce the structural capacity of the reef light due to capacity of the original design.

The protective coating (paint) for the reef light is in fair condition with isolated areas that have failed in Sections 1 through 4. Section 5 has 100% coating loss.

Recommendations and rehabilitation costs for the Carysfort Reef Light are provided in Table 1.

TABLE 1
EXECUTIVE SUMMARY TABLE
CARYSFORT REEF LIGHT

Recommended Repairs		Rehabilitation Costs
Required in Near Term	1. Clean and coat exterior metal/struts. 2. Replace broken/deteriorated tie rods and turnbuckles. 3. Repair/plug first floor drain grates in dwelling. 4. Repair boat landing ladders. 5. Replace lantern room catwalk grating, framing and handrails. 6. Replace timber walkway to boat landing. 7. Repair cracks in watch room exterior wall. 8. Replace entrance hatch. 9. Reconnect ladder at top of interior stairwell. 10. Replace solar panel. 11. Replace missing porthole.	$2,200,000
Deferrable	1. Seal cracks in concrete piles. 2. Replace handrail and grating brackets on exterior stairwell. 3. Repair bottoms of wall panels. 4. Clean and coat interior of dwelling. 5. Repair cracks in dwelling floor plates. 6. Replace floor and ceiling paneling. 7. Replace broken portholes. 8. Replace passive anodes.	$250,000

2.0 INTRODUCTION

This report was prepared by Infrastructure Engineers, Inc. (IEI) for the United States Coast Guard Civil Engineering Unit Miami under Task Order No. HSCG82-10-J-PMV228. The point of contact for the United States Coast Guard (USCG) is LT J.N. Lopez. The scope of work for the Task Order included, but not limited to, site survey, underwater inspection, above water inspection, reporting of site damage through sketches and pictures, proposing methods of repair, development of rough order magnitude cost estimates for the repairs and development of summary reports. The objective of the inspection is to detect and report conditions requiring maintenance or repair before such conditions become safety, structural, or major maintenance problems, or identify those which already are. This report represents the findings from the inspection of the reef light and associated repair recommendations.

The key personnel responsible for the development of this report are listed in Table 2-1.

TABLE 2-1
KEY PERSONNEL

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A team led by a registered professional engineer-diver conducted the inspection. Access to the reef light was obtained by boat. The boat was launched from a boat ramp at the Homestead Bayfront Park.

The above water inspection consisted of a 100% visual inspection of the interior and exterior of the reef light to observe and record general conditions and gross measurements. Rope access techniques performed by SPRAT certified engineer-climbers were used to inspect above water components. The underwater inspection generally consisted of a Level I “swim by” visual inspection over 100% of the accessible substructure units (SSUs) from the high water mark to the channel bottom. The purpose of the inspection was to gather sufficient data to develop Engineering Assessment Ratings (Table 2-2), develop conceptual repair recommendations and to provide budget estimates for structural repairs.

The Engineering Assessment Ratings for the structures are based on engineering judgment and assessment descriptions. Ratings are used to describe the existing in-place structure relative to its condition when newly built.

TABLE 2-2
ENGINEERING ASSESSMENT RATINGS

Assessment Rating	Description
Good	None to minor defects and deterioration observed.
Satisfactory	Minor to moderate defects and deterioration observed, but no overstressed observed.
Fair	All primary structural elements are sound, but minor to moderate defects and deterioration observed. Localized areas of moderate to advanced deterioration may be present but do not significantly reduce the load bearing capacity of the structure.
Poor	Advanced deterioration or overstressing observed on widespread portions of the structure but has not progressed to a level that has significantly affected the load bearing capacity of primary structural components.
Serious	Advanced deterioration, overstressing or breakage may have significantly affected the load bearing capacity of primary structural components. Local failures are possible.

3.0 BACKGROUND

Built in 1852, Carysfort Reef Light is located six nautical miles east of Key Largo in Florida. The structural skeleton is constructed of screw piles that support an octagonal iron-pile skeleton with a circular dwelling, and the light stands 100' above the water. An iron stairwell cylinder is enclosed within the structure. The structural framing, as well as the exterior of the dwelling and lantern room, are painted red. Flashing characteristics for the light are: flashing white and red, every third flash is red.

4.0 CARYSFORT REEF LIGHT INSPECTION

4.1 PROCEDURES

A 4-man inspection team from IEI conducted an inspection on September 10, 2010. Inspections included visual observations by professional engineers inside and outside the structure, photographs, and taking sufficient measurements to generally characterize the structure. Certified engineer-climbers accessed all components of the exterior structural framing utilizing rope access techniques. A certified engineer-diver performed a visual inspection of submersed components and noted all underwater deficiencies.

4.2 ELEMENTS INSPECTED

The reef light was divided into the following elements for purposes of the inspection:

1. Structural Framing
2. Dwelling
3. Boat Landing
4. Inside Tower (Lantern Room and Stairwell)
5. Underwater Components
6. Paint Systems

The overall schematic of the reef light is provided in Figures 6-1 and 6-2, identifying the location of these elements. Identification of additional elements is provided in the inspection photographs (Section 6). Structural framing items included struts and collars. For the interior rooms, inspections included roof/framing, ceilings, windows/doors, and floor plates. Additional items specific to each component are identified in their respective sections.

The foundation for the structure is comprised of nine 12” diameter iron piles drilled into the coral to support the tower. Each pile passes through an iron disc on top of the coral. No defects were observed in the structure indicate that there is a weak or failing foundation system.

4.3 OBSERVED CONDITIONS AND ASSESSMENTS

Overall, the reef light is in fair condition. All columns and bracing have minor coating loss with localized areas of heavy corrosion and section loss. The stairwell cylinder is considered a structural element; the cylinder has multiple cracks in the wall panels. Most of the cracked areas have been reinforced with supplemental steel plates. The dwelling has coating loss and light corrosion on all metal surfaces. Floor plates and wall panels have local deformations and minor cracks. In the dwelling interior, the wood paneling has peeling paint and some paneling is missing. All electrical and utility systems are inoperable. Coating loss and light corrosion are prevalent inside of the stairwell and several portholes are broken or missing. The interior of the lantern room has minor deterioration. The exterior lantern room catwalk has moderate to heavy corrosion, missing sections of handrail, and areas of section loss in the grating and secondary catwalk supports. Anode brackets are broken and no anodes are present at Column 9 below the waterline. Currently these defects do not significantly reduce the structural stability of the light structure.

The protective coating system is in fair condition resulting in widespread corrosion to varying degrees throughout the structure. The windows and doors for the structure are in satisfactory condition.

The following generally summarizes the findings to the individual sections:

4.3.1 Structural Framing

Nomenclature

For the purposes of this report, the columns of the structural frame are designated with numbers 1 through 8 counter-clockwise starting at the west column. Column 9 is in the center of the structure. In order from the top down, the light is comprised of the lantern room, watch room and tower sections 1 through 5. Tower sections are numbered starting at the bottom of the lantern room and are divided by tie rod connection joints. The dwelling is in Section 3 and Section 5 is partially in the water.

Primary Members

The columns are in satisfactory condition. Columns in Sections 1 and 2 have minor coating loss with previous pitting that has been painted over. This pitting is up to 3/8" deep in the 6" above and below the collars that join Sections 1 and 2 and up to 1/4" deep in the 2" above and below the intermediate collars within each section (Photos 6-2 and 6-3). Elsewhere, the columns in Sections 1 and 2 have isolated areas of pitting less than 1/16" deep.

Columns in Section 4 have minor coating loss. The area 6" above the lower tie rod connections on columns 7 and 8 in Section 4 have previous heavy pitting up to 3/4" deep (Photo 6-4). Columns in Section 5 have 100% coating loss with heavy corrosion with areas of pitting up to 1/4" deep (Photo 6-5).

Secondary Members

The tie rods and turnbuckles between panel points are in fair condition. Tie rods in Sections 1 and 2 have approximately 30% coating loss with light to moderate corrosion typical. These rods have moderate to heavy corrosion with some pack rust at connection points and at the U-bolt where diagonal tie rods cross (Photo 6-6). Two turnbuckles are broken in Section 1. One leg of the lower turnbuckle on the diagonal tie rod between Column 4 and the stairwell cylinder is broken at the stairwell cylinder (Photo 6-7). The lower turnbuckle on the diagonal tie rod between Column 6 and the stairwell cylinder is broken at the stairwell cylinder (Photo 6-8). At Column 7 in Section 1, 30% of the end of the eye hook at the lower connection of the diagonal tie rod between Columns 6 and 7 has deteriorated away. All horizontal and radial struts are in good condition with minor coating loss.

In Section 4, the upper ends of the diagonal tie rods have moderate to heavy corrosion and negligible section loss. The lower ends of the diagonal tie rods at the column connections are heavily deteriorated with 30% to 50% section loss typical near the end hooks. The lower end of the diagonal tie rod from Column 6 to 7 has 70% section loss at Column 6 (Photo 6-9). Several of the diagonal tie rods are broken below the lower turnbuckle: between Columns 1 and 9 at Column 9 (Photo 6-10), between Columns 3 and 4 at Column 4, between Columns 4 and 5 at Column 5, and both at Column 8.

In Section 5, the upper ends of the diagonal tie rods are heavily corroded, primarily at Columns 1, 7, and 8 (Photo 6-11). The radial and horizontal struts at the top of Section 5 have moderate to heavy corrosion with isolated areas of delamination.

4.3.2 Dwelling

The dwelling is in fair condition overall. The first floor has one room with a cylindrical fresh water tank in the center. Wall panels around the first floor are numbered 1 through 24 counter-clockwise starting at the exterior door between Columns 1 and 8. The previous living quarters are on the second floor of the dwelling. The second floor has four rooms numbered counter-clockwise from the entrance to the tower stairwell.

Exterior

The exterior of the dwelling has approximately 15% coating loss with light corrosion. All of the shudders are in good condition. There are isolated areas of corrosion and pitting up to 4" diameter and up to 1/4" deep throughout. The bottom 8" to 10" of all wall panels has cracks up to 1/4" wide at random locations; some pieces are fractured off (Photo 6-12).

The roof membrane is in good condition with minor rust stains at the edges of the roof plates. There are up to 1" vertical offsets between roof plates; however, this condition was likely as-built. The roof has eight hatches which are in good condition with minor coating loss and light corrosion. A steel safety cable circles the perimeter of the roof and has light corrosion (Photo 6-13). An iron davit is located on the north side of the dwelling exterior between Columns 1 and 8. The davit assembly has 50% coating loss. The primary davit member is heavily corroded with 20% section loss (Photo 6-14).

First Floor

The underside of the floor has approximately 40% coating loss with light corrosion. On the interior, the floor has 80% coating loss with light to moderate corrosion and random areas of heavy pitting (Photo 6-15). The entrance hatch has heavy corrosion with up to 1/16" deep pitting (Photo 6-16). Fifty percent of each of the vent/drain grates in the floor have 100% section loss (Photo 6-17). Two of the grates near Columns 2 and 4 have been plugged with solid timber covers. Floor plates around Columns 1, 2, 5, 7 and 8 have heavy corrosion with up to 100% section loss extending as far as 7" away from the column (Photo 6-18). Near Columns 2 and 8, the floor plates are cracked up to 34" long due to buckling of the plates. Near Column 3, the outer floor plate is depressed up to 1 1/2" with a 1" wide gap between floor plates.

The interior walls have approximately 30% coating loss with random areas of corrosion and pitting throughout; corrosion and pitting is more advanced in the lower third of each of the wall panels. The glass in the portholes in Wall Panels 2, 4 and 5 are broken. Wall Panel 24 has an up to 1/32" wide x 34" long vertical crack with rust stains (Photo 6-19). Bolts connecting wall panels have light to moderate corrosion; isolated bolt heads at Panel 3 are heavily corroded with up to 30% section loss (Photo 6-20). The ceiling has approximately 60% coating loss, primarily near the exterior wall with light to moderate corrosion. Handrails around the entrance hatch are missing. The fresh water tank is in good condition with light corrosion around plate edges and rivets. All electrical systems are non-functional and wiring is exposed in several locations (Photo 6-21).

Second Floor

Twenty percent total of the flooring is missing in random locations throughout all rooms. The subfloor is exposed in several locations with moderate deterioration. All doors are in good shape except for several random loose hinges. A 3 1/2' long x 3' high section of wall paneling is missing above the

entrance to the tower stairwell in Room 1. Approximately 60% of the ceiling paneling is missing in Room 1 (Photo 6-22). All kitchen fixtures are inoperable.

Approximately 70% of the ceiling paneling is missing in Room 2. In addition, one vertical wall panel is missing adjacent to the exterior door. Room 2 contains a small pump room and bathroom. All bathroom fixtures and pump room equipment are inoperable.

In Room 3, approximately 30% of the ceiling paneling is missing and there is a 1' wide x 3' high hole in the base of the wall paneling (Photo 6-23). Approximately 40% of the ceiling paneling is missing in Room 4. Also in Room 4, the flooring in the portico beyond the exterior door has moderate deterioration.

4.3.3 Boat Landing and Exterior Stairs

The boat landing is in fair condition. Two handrail brackets at the second stair landing are broken (Photo 6-24). Two U-bolts that secure the deck grating to the horizontal strut at the first landing are broken. Two timber beams support the walkway from the boat landing to the first stair landing. One of these beams has heavy deterioration around the bolt holes at the first landing (Photo 6-25). A 12' by 8' area of deck grating at the southwest corner of the boat landing is missing clips intended to hold it to the steel frame. The steel frame supporting the landing has moderate to heavy corrosion with multiple small perforations in the webs (Photos 6-26 and 6-27). The concrete pile at the southeast corner of the boat landing has an area of spalling and delamination around the full perimeter of the top 2' of the pile (Photo 6-28). Steel collars at the tops of all of the boat landing piles have heavy corrosion.

The timber whaler at the top of the north side of the boat landing has an area of heavy deterioration 6' long by up to 4" deep. The timber mooring piles are in good condition; however, the rubber rub rails are too small. Ladders on the boat landing are located on the north and east sides. Welds attaching the rails of the north ladder to the platform are cracked while the bottom of this ladder is secured to the platform with rope. Bolts for connecting the bottom of the east ladder to the boat landing are missing; the ladder is not secured to the platform, it is only resting on a timber beam (Photo 6-29).

4.3.4 Inside of Tower, Watch Room, and Lantern Room

The tower and Lantern Room are in fair condition. Approximately 20% of the timber floor in the lantern room is deteriorated. The wood paneling around the walls of the lower portion of the lantern room has approximately 40% coating loss. A 2' wide section of wall paneling is damaged (Photo 6-30). The exterior door frame has cracks at top and bottom up to 1/16" wide (Photo 6-31). Semi-circular iron members covering the joints between wall sections on the exterior of the lower portion of the watch room have cracks up to 1/4" wide with heavy corrosion (Photo 6-32).

The window frames in the upper portion of the lantern room have approximately 20% coating loss with light corrosion. Nine window panes are cracked in the top row, 1 in the middle row, and three in the bottom row (Photo 6-33). Three sections of the top window sill have moderate corrosion. Vents around the interior catwalk have isolated areas of moderate to heavy deterioration. The interior of the lantern room roof has approximately 10% coating loss with light corrosion.

The exterior catwalk grating has moderate to heavy corrosion with areas of 100% section loss (Photo 6-34). Multiple U-bolts securing the catwalk grating are broken. Several secondary catwalk support members have 100% section loss (Photo 6-35). Four handrail sections are missing or broken (Photo 6-36). The frame supporting the solar panels has light corrosion. One solar panel is missing.

The stairs are in fair condition. Wood paneling in the stairwell within the dwelling has 70% coating loss. At the level of the roof, a 4' long by 18" high area of paneling is missing (Photo 6-37). Hinges on the door leading from the stairs to the dwelling roof are broken (Photo 6-38). The stairs are a combination of metal and timber treads; all are in good condition (Photo 6-39). Above the dwelling, the stairs are enclosed in an iron cylinder. The inside of the stairwell has 40% coating loss. Two portholes are broken and one is missing near the top. The ladder from the stairwell into the lantern room is not connected at the top or the bottom (Photo 6-40).

Each of the eight stairwell cylinder wall panels just below the lantern room has one vertical crack up to 1/8" wide. These cracks typically extend between 1' and 2' down from the top of the panel (Photo 6-41). The wall panel near Column 8 has two cracks. The crack in the wall panel near Column 5 extends from the top of the panel to 10" from the bottom of the panel (Photo 6-42). Supplemental steel plates are bolted to the top half of each stairwell wall panel on the interior of the stairwell (Photo 6-43).

4.3.5 Underwater Components

The underwater components of the reef light are in satisfactory condition. No defects were noted at the time of inspection (Photo 6-44). Brackets for cathodic protection anodes are broken off of Column 9; no anodes are present (Photo 6-45).

4.3.6 Paint Systems

The exterior paint is in fair condition with isolated areas that have failed in Sections 1 through 4. Section 5 has 100% coating loss. Paint samples were taken during the inspection by removing the paint down to the base metal. Paint samples were not taken from the dwelling exterior doors and shutters since they are made of an unpainted polymer type material. Laboratory results for TCLP analysis of paint samples taken indicate the lead in the red paint does not exceed the Extraction Procedure Toxicity concentration for classification of a solid waste as a characteristic hazardous waste (see Appendix B).

5.0 RECOMMENDATIONS AND REHABILITATION COSTS

5.1 GENERAL

The repair recommendations contained herein are preliminary and are to be used for general budgeting purposes. The actual method of repair should result from subsequent design level inspections and the discretion of the Engineer of Record.

The Preliminary Cost Estimate tables (Appendix A) prioritize the repair recommendations and provide a breakdown for the costs associated with the recommendations. The repairs were prioritized into two classifications identified as Near Term and Deferrable Repairs. Near Term repairs were identified where critical system components were either failed or expected to fail and/or be adversely impacted without maintenance/repairs within the next five years. Deferrable Repairs were called for where the system element is not critical for current operation or not anticipated to warrant maintenance within the next five years.

5.2 SPECIFIC RECOMMENDATIONS

The following Near Term and Deferrable Repairs are recommended for the reef light:

A. Near Term Repairs ($2,200,000)

a. Structural Framing:
   i. Clean and coat the iron struts, columns and metal surfaces
   ii. Replace broken tie rods
   iii. Repair/plug first floor drain grates in dwelling.

b. Dwelling:
   i. Replace entrance hatch

c. Dock Platform:
   i. Repair boat landing ladders
   ii. Replace timber walkway to boat landing

d. Inside of Tower and Lantern Room:
   i. Replace lantern room catwalk grating, framing and handrails.
   ii. Repair cracks in watch room exterior wall
   iii. Reconnect ladder at top of interior stairwell
   iv. Replace missing solar panel
   v. Replace missing porthole

B. Deferrable Repairs ($250,000)

a. Clean and coat interior of dwelling
b. Seal cracks in concrete piles
c. Replace handrail and grating brackets on exterior stairwell
d. Repair bottoms of dwelling wall panels
e. Repair cracks in dwelling wall and floor plates
f. Replace dwelling floor and ceiling paneling
g. Replace broken portholes
h. Replace passive anodes

The estimated cost of the Near Term and Deferrable repairs is summarized in Appendix A. The individual line items in the cost estimate are accurate in context of the magnitude of the total project cost. It should be anticipated that individual item costs, taken separately, would be greater due to the repeated mobilization, temporary scaffolding, and cost associated with loss in economies inherent with a larger project.

These estimates are based on 2010 costs and should be adjusted for the actual year construction is proposed to commence. The cost estimate includes mobilization/demobilization, overhead, profit, tax, and contingencies. It is noted that this type of project is difficult to accurately estimate due to the specialized work, limited pool of contractors and lack of historical pricing. The Coast Guard may choose to increase the 25% contingent carried in the estimate to account for these conditions.

If the recommended repairs are not performed, the structural components will continue to deteriorate. However, due to the member configuration, size and expected rate of deterioration, significant impact to the structural capacity of the reef light would not be expected for 15 to 25 years. It is recommended that the broken or deteriorated tie rods and turnbuckles be replaced, the drain grates in the dwelling be repaired, the boat landing ladders be repaired, the lantern room catwalk be replaced, the timber boat

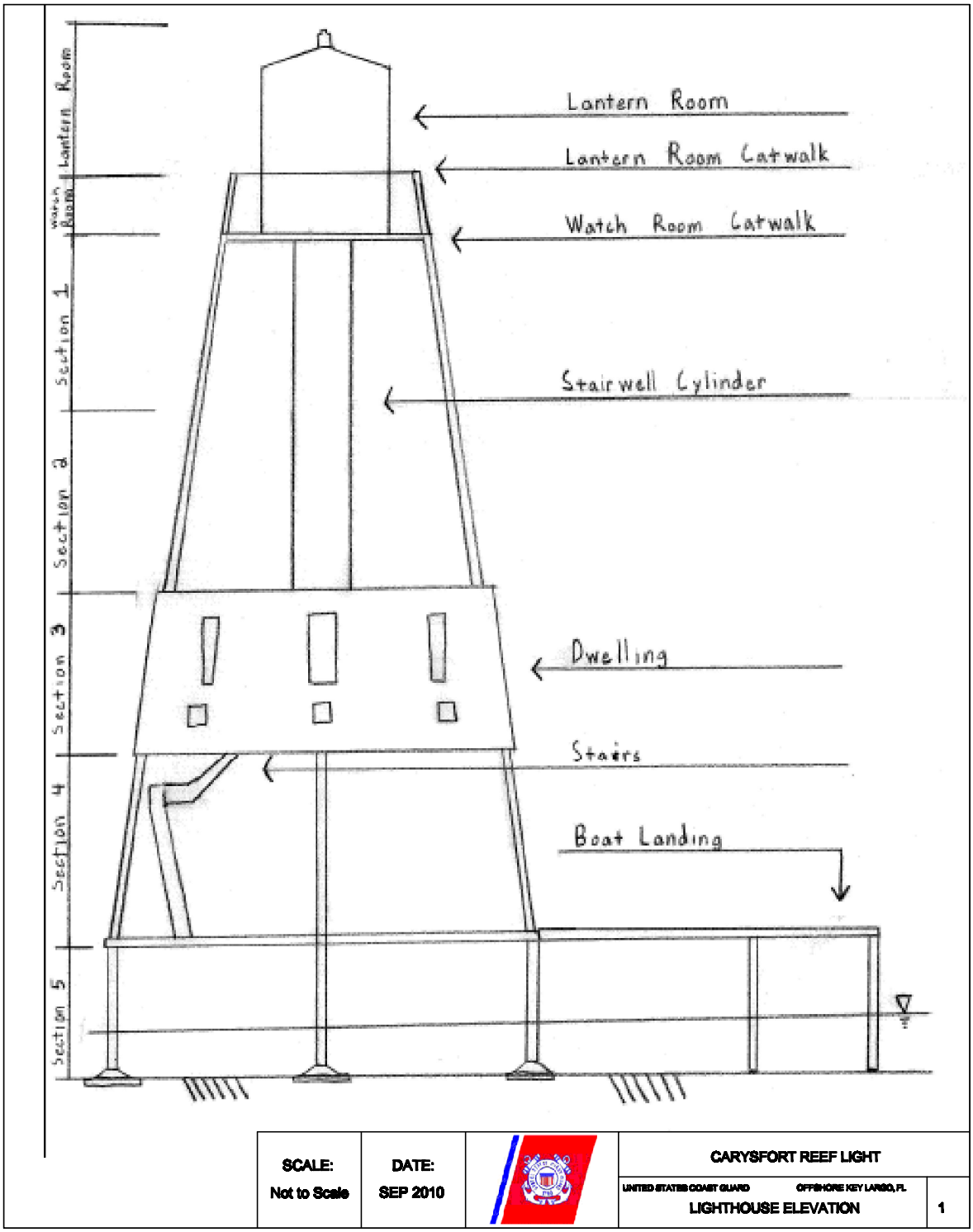
landing walkway be replaced, cracks in the watch room exterior wall be repaired, the entrance hatch be replaced, the ladder at the top of the stairwell be reconnected, the missing solar panel be replaced, and the missing porthole be replaced.

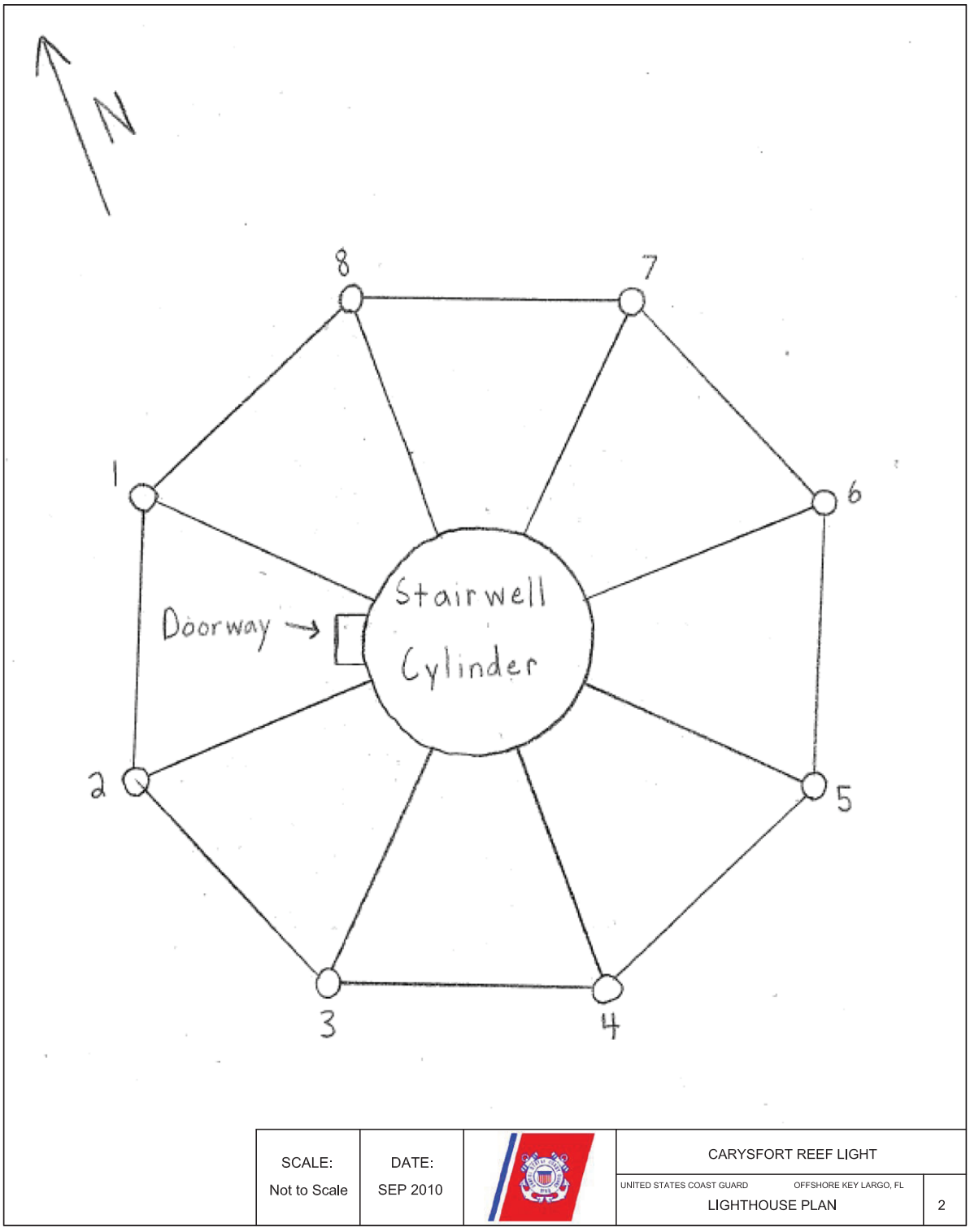
6.0 PHOTOGRAPHS AND FIGURES

Photo 6-1:
Overall view of reef light, looking South.

Task Order No. HSCG82-10-J-PMV172
Contract No. HSCGG1-10-D-PRV090

Carysfort Reef Light
September 2010





SCALE:	DATE:		CARYSFORT REEF LIGHT	
Not to Scale	SEP 2010		UNITED STATES COAST GUARD OFFSHORE KEY LARGO, FL LIGHTHOUSE PLAN	2

Photo 6-2

Pitting above and below intermediate column connection collars.

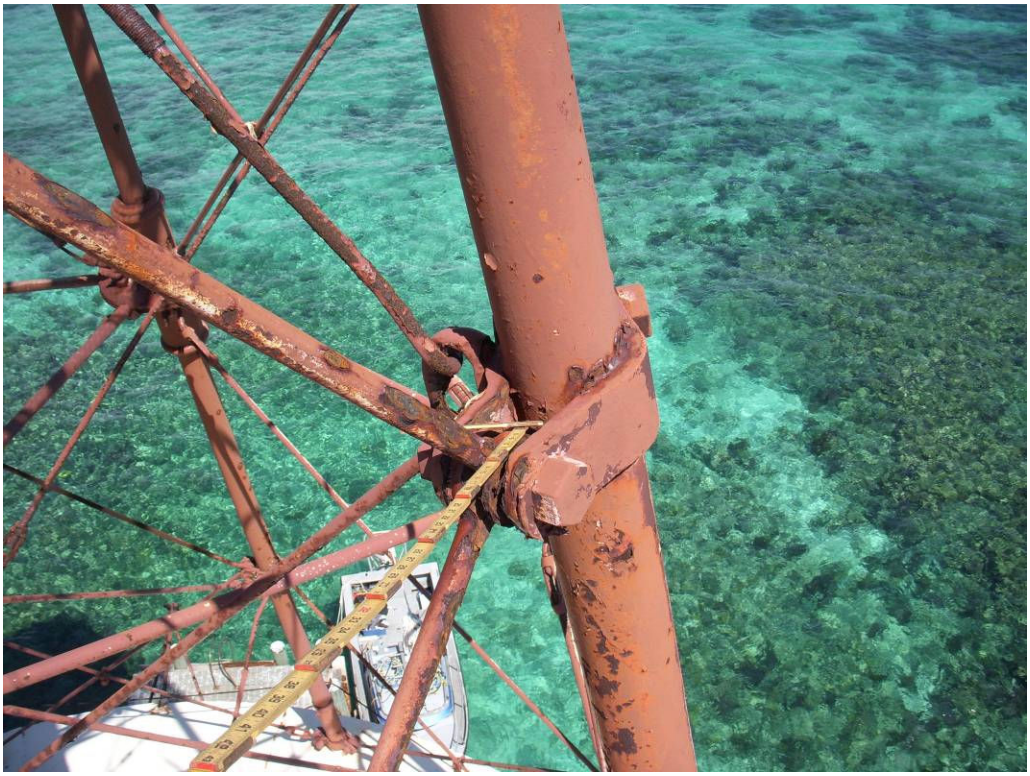


Photo 6-3

Pitting above and below intermediate tie rod connection collars.

Photo 6-4

Heavy pitting above the lower tie rod connections on column, Section 4.

Photo 6-5

Coating loss with heavy corrosion and pitting in Section 5.

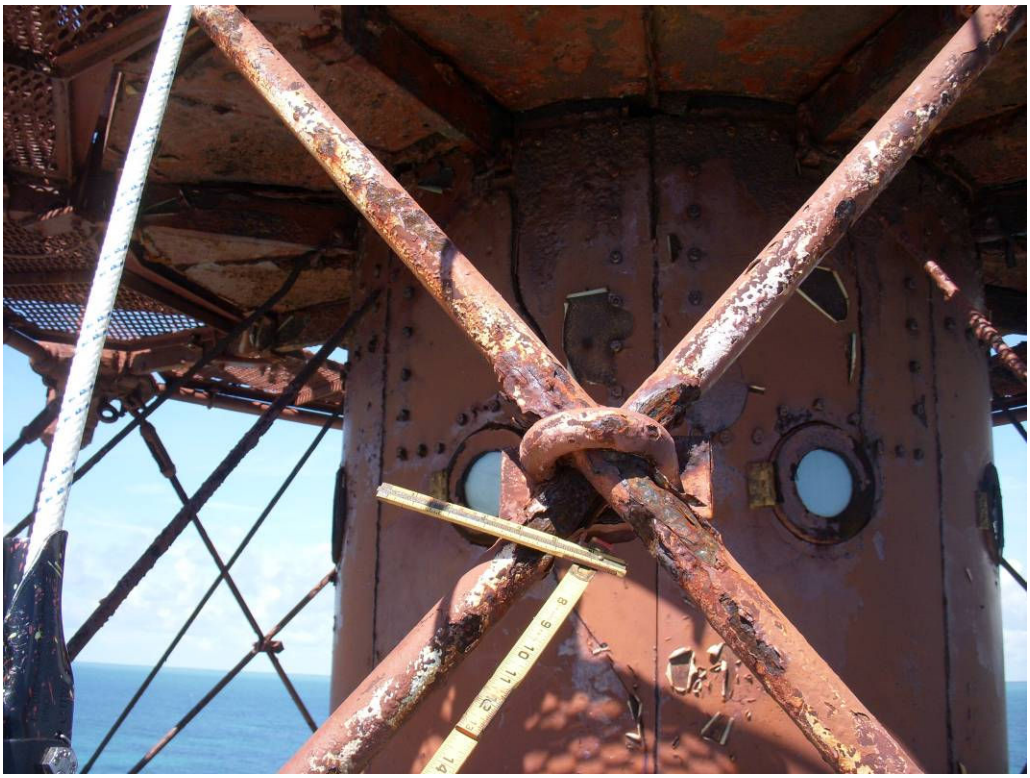


Photo 6-6

Typical moderate to heavy corrosion with some pack rust on tie rod.

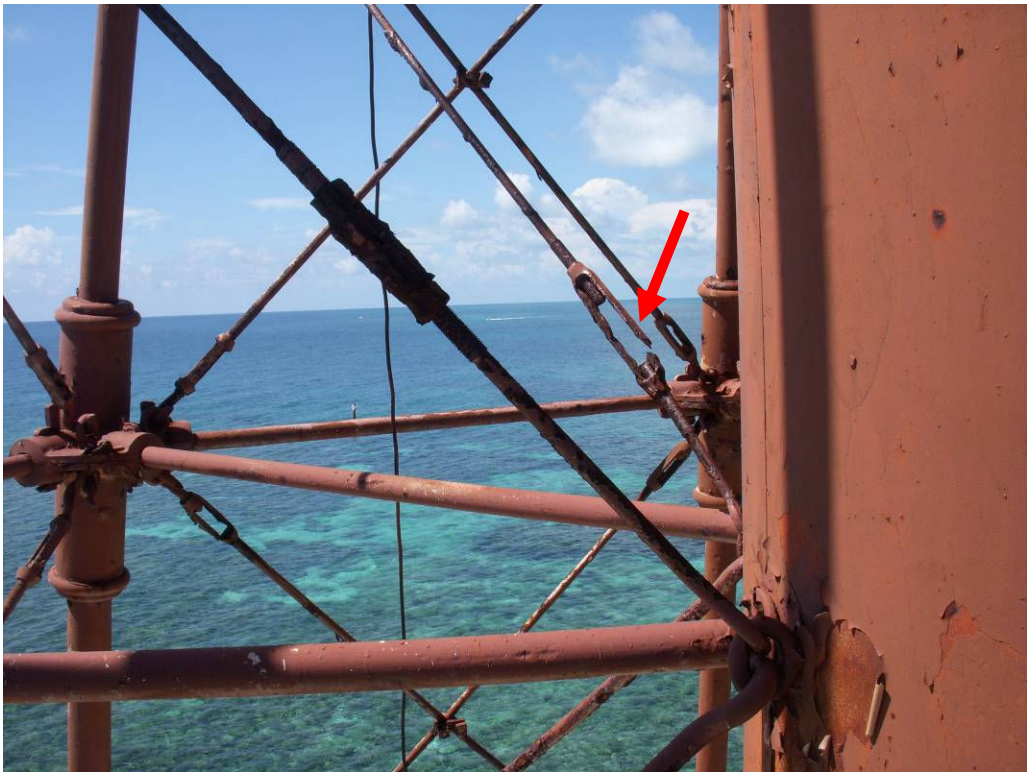


Photo 6-7

Broken leg of turnbuckle on tie rod between stairwell and Column 4 in Section 1.

Photo 6-8

Broken leg of turnbuckle on tie rod between stairwell and Column 6 in Section 1.

Photo 6-9

Section loss on diagonal tie rod at Column 6 in Section 4.

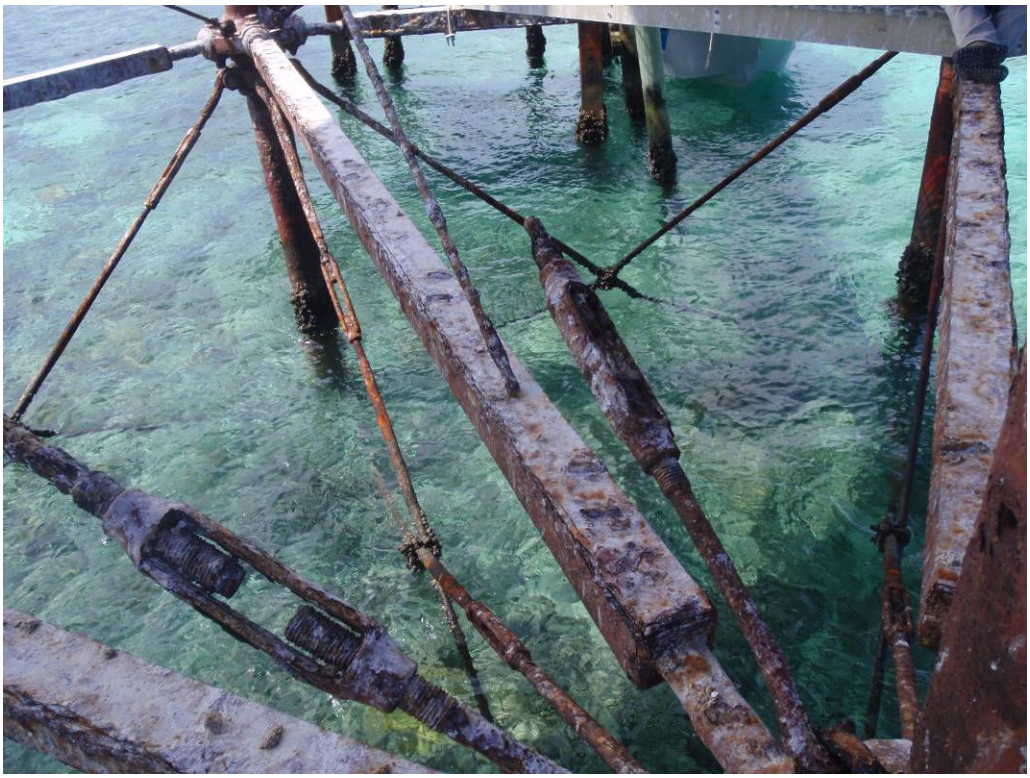


Photo 6-10

Broken tie rods in Section 4 between Columns 1 and 9.

Photo 6-11

Heavily corroded tie rods in Section 5 at Column 8.

Photo 6-12

Typical fractured dwelling wall panel.

Photo 6-13

Light corrosion on steel safety cable around the dwelling roof.

Photo 6-14

Heavily corroded davit on dwelling roof.

Photo 6-15

Light to moderate coating loss and heavy pitting on the first floor dwelling interior.

Photo 6-16

Heavy corrosion and 1/16” deep pitting on entrance hatch.

Photo 6-17

Typical 100% section loss on vent/drain grates on first floor of dwelling.

Photo 6-18

Heavy corrosion with section loss on first floor dwelling floor plates, shown at Column 7.

Photo 6-19

Vertical crack with rust stains in dwelling Wall Panel 24 on first floor.

Photo 6-20

Typical corrosion on dwelling wall panel bolts.

Photo 6-21

Typical non-functional electrical system with exposed wiring.

Photo 6-22

Missing ceiling and wall paneling in Room 1 on the dwelling second floor.

Photo 6-23

Missing ceiling paneling and hole in base of wall panel in Room 3 on the dwelling second floor.

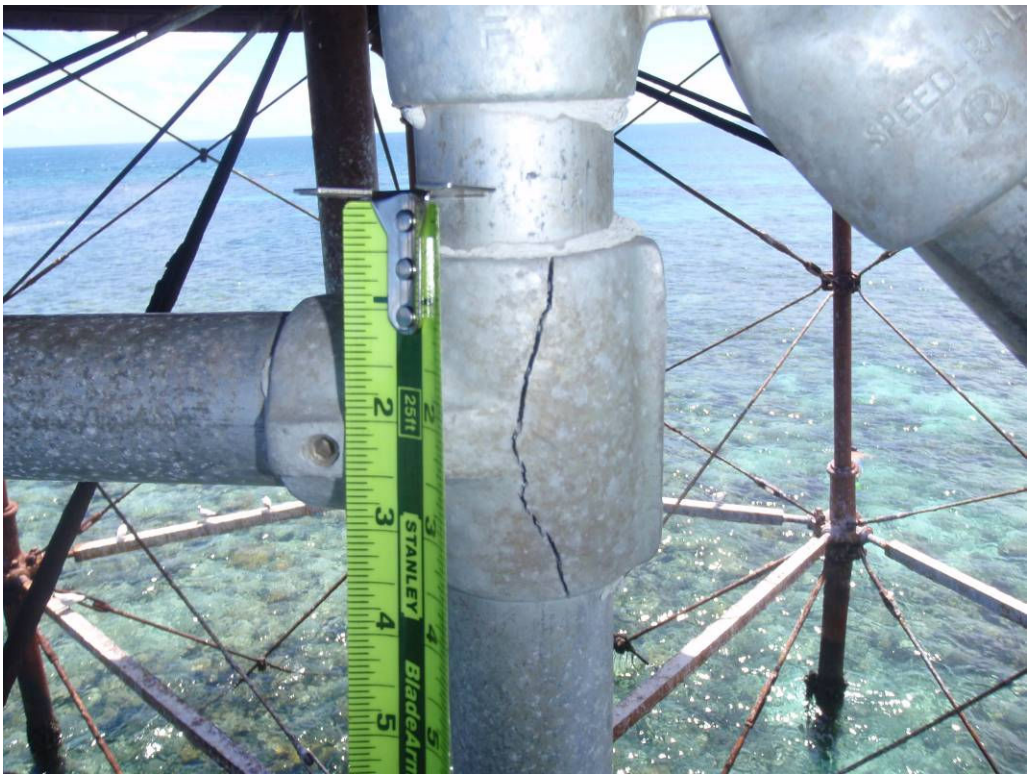


Photo 6-24

Broken handrail bracket on exterior stairwell in Section 4.

Photo 6-25

Heavy deterioration of the timber boat landing walkway beam at connection.

Photo 6-26

Moderate to heavy corrosion on steel frame with multiple small perforations in webs.

Photo 6-27

Moderate to heavy corrosion on steel frame with multiple small perforations in webs.

Photo 6-28

Area of spalling and delamination on boat landing concrete pile.

Photo 6-29

Missing bolts at base of east boat landing ladder.

Photo 6-30

Damaged wall paneling in watch room.

Photo 6-31

Cracks in watch room exterior door frame.

Photo 6-32

Cracks and heavy corrosion on iron members covering the joints between exterior watch room wall sections.

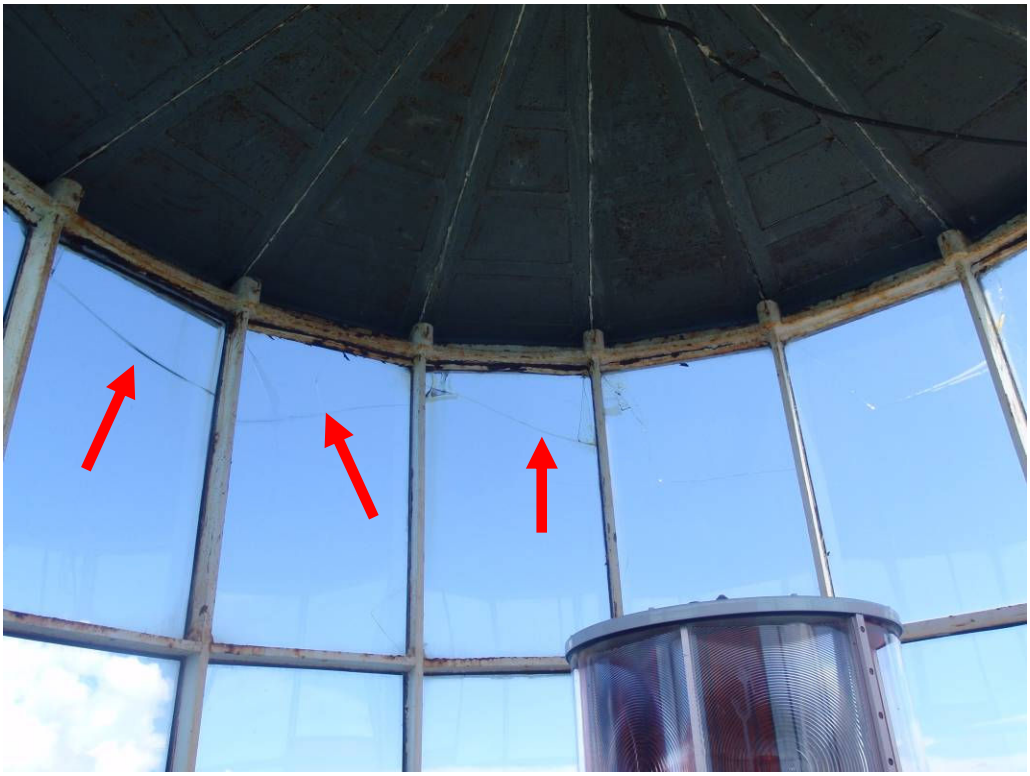


Photo 6-33

Cracked window panes in lantern room.

Photo 6-34

Moderate to heavy corrosion on exterior watch room catwalk grating.

Photo 6-35

Section loss on secondary watch room catwalk support members.

Photo 6-36

Typical broken handrail sections on watch room catwalk.

Photo 6-37

Missing wall paneling inside of stairwell.

Photo 6-38

Broken hinges on the door leading from the stairs to dwelling roof.

Photo 6-39

Stairwell treads are in good condition.

Photo 6-40

Ladder from the stairwell to the lantern room is not connected at the top or the bottom.

Photo 6-41

Vertical cracks in the stairwell wall panels below the watch room.

Photo 6-42

Crack in the stairwell wall panel at the top near Column 5 extends from the top of the panel to 10” from the bottom of the panel.

Photo 6-43

Supplemental steel plates bolted to the top half of each interior stairwell wall panel at the top of the stairwell.

Photo 6-44

Underwater components are in satisfactory condition.

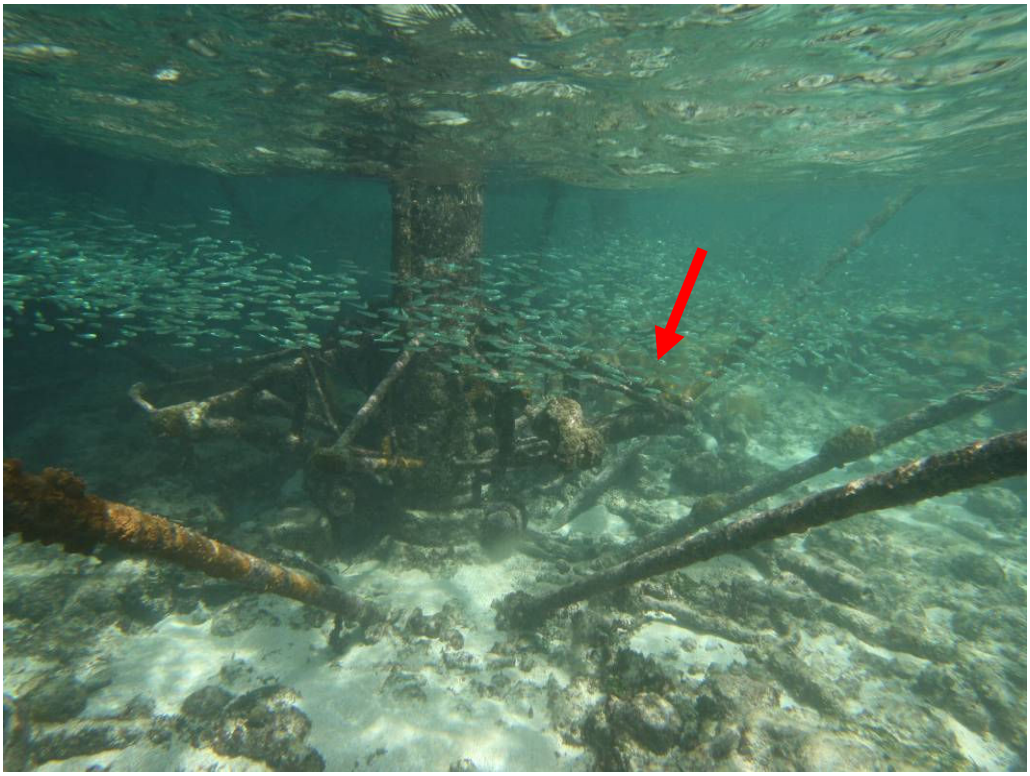


Photo 6-45

Broken brackets for cathodic protection anodes, no anodes present.

7.0 APPENDIX A: COST ESTIMATE

Near Term Repairs

INFRASTRUCTURE ENGINEERS, INC.
consulting engineers | commercial divers

DIVISION SUMMARY

Project Name: **Carysfort Reef Lighthouse**
Offshore Key Largo, FL
Engineer's Estimate:
Unit:

Date: September 2010
Division Summary:
Sheet No.: 1

ITEM #	DESCRIPTION	MATERIAL	LABOR	EQUIPMENT	SUB-TOTAL M,L,E
		M- TOTAL	L - TOTAL	E - TOTAL	
DIVISION 1 - GENERAL CONDITIONS					
0131	Project Management / Coordiantion		$ 50,000.00		$ 50,000.00
0154	Mobilization	$ 500.00	$ 10,000.00	$ 8,000.00	$ 18,500.00
DIVISION 5 -METALS					
0505	Repair lantern room catwalk	$ 7,500.00	$ 2,800.00	$ 450.00	$ 10,750.00
0512	Replace broken tie rods	$ 12,000.00	$ 7,000.00		$ 19,000.00
0512	Replace entrance hatch	$ 350.00	$ 500.00	$ 100.00	$ 950.00
0512	Plug vent/drain grates	$ 500.00	$ 200.00		$ 700.00
0512	Repair cracks in lantern room exterior wall	$ 200.00	$ 700.00	$ 100.00	$ 1,000.00
0551	Repair boat landing ladders	$ 500.00	$ 200.00	$ 100.00	$ 800.00
0551	Reconnect ladder at top of interior stairwell	$ 50.00	$ 50.00	$ 50.00	$ 150.00
DIVISION 6-WOOD, PLASTICS, AND COMPONENTS					
0613	Replace timber boat landing walkway	$ 400.00	$ 300.00	$ 50.00	$ 750.00
DIVISION 8-OPENINGS					
0851	Replace missing porthole	$ 2,400.00	$ 1,500.00	$ 750.00	$ 4,650.00
DIVISION 9-FINISHES					
0901	Sealant of Exterior Surfaces	$ 5,000.00	$ 9,000.00	$ 2,000.00	$ 16,000.00
0997	Clean and Coat Exterior Structural Steel	$ 200,000.00	$ 500,000.00	$ 400,000.00	$ 1,100,000.00
DIVISION 26-ELECTRICAL					
2605	Replace Solar Panels	$ 300.00	$ 100.00		$ 400.00
	SUBTOTAL	$ 229,700.00	$ 582,350.00	$ 411,600.00	$ 1,223,650.00
	SALES TAX (4%)	$ 9,188.00			$ 9,188.00
	LABOR BURDEN (35%)		$ 203,822.50		$ 203,822.50
	SUBTOTAL				$ 1,436,660.50
	CONTINGENCY (25%)				$ 359,165.13
	CONTRACTOR'S OVERHEAD (10%)				$ 179,582.56
	CONTRACTOR'S PROFIT (10%)				$ 179,582.56
	TOTAL				$ 2,154,990.75
				ESTIMATE	$ 2,200,000.00

Deferrable Repairs

INFRASTRUCTURE ENGINEERS, INC.
consulting engineers | commercial divers

DIVISION SUMMARY

Project Name: **Carysfort Reef Lighthouse**
Offshore Key Largo, FL
Engineer's Estimate:
Unit:

Date: September 2010
Division Summary:
Sheet No.: 1

ITEM #	DESCRIPTION	MATERIAL	LABOR	EQUIPMENT	SUB-TOTAL M,L,E
		M- TOTAL	L - TOTAL	E - TOTAL	
DIVISION 1 - GENERAL CONDITIONS					
0131	Project Management / Coordiantion		$ 10,000.00		$ 10,000.00
0154	Mobilization	$ 1,000.00	$ 7,500.00	$ 5,000.00	$ 13,500.00
DIVISION 3-CONCRETE					
0364	Repair cracks in concrete piles	$ 350.00	$ 800.00	$ 150.00	$ 1,300.00
DIVISION 5 -METALS					
0512	Repair bottoms of fractured wall panels	$ 2,300.00	$ 2,000.00	$ 700.00	$ 5,000.00
0512	Repair dwelling floor plates	$ 500.00	$ 700.00	$ 300.00	$ 1,500.00
0512	Replace cathodic protection	$ 1,000.00	$ 8,000.00	$ 5,000.00	$ 14,000.00
0552	Replace broken railing and deck brackets	$ 400.00	$ 200.00	$ 50.00	$ 650.00
DIVISION 6-WOOD, PLASTICS, AND COMPONENTS					
0612	Replace interior floor/ceiling panels	$ 1,500.00	$ 200.00	$ 100.00	$ 1,800.00
DIVISION 8-OPENINGS					
0851	Replace broken portholes	$ 2,400.00	$ 1,500.00	$ 750.00	$ 4,650.00
DIVISION 9-FINISHES					
0997	Clean and Coat Interior Surfaces	$ 15,000.00	$ 52,000.00	$ 15,000.00	$ 82,000.00
	SUBTOTAL	$ 24,450.00	$ 82,900.00	$ 27,050.00	$ 134,400.00
	SALES TAX (4%)	$ 978.00			$ 978.00
	LABOR BURDEN (35%)		$ 29,015.00		$ 29,015.00
	SUBTOTAL				$ 164,393.00
	CONTINGENCY (25%)				$ 41,098.25
	CONTRACTOR'S OVERHEAD (10%)				$ 20,549.13
	CONTRACTOR'S PROFIT (10%)				$ 20,549.13
	TOTAL				$ 246,589.50
				ESTIMATE	$ 250,000.00

8.0 APPENDIX B: PAINT SAMPLE TEST RESULTS

PAINT TESTING REPORT

Six Off-Shore USCG Light Structures
Monroe County, Florida
Infrastructure Engineers Job 08132USCG

Terracon Project No. 37107128
October 7, 2010

Prepared for:

Infrastructure Engineers
1460 John B. White Senior Boulevard, Suite 1C
Spartanburg, South Carolina 29306

Prepared by:

TERRACON
Orlando, Florida

TABLE OF CONTENTS

Terracon

LIST OF APPENDICES

PAINT TESTING REPORT

Six Off-Shore USCG Light Structures
Monroe County, Florida
Infrastructure Engineers Job 08132USCG

Terracon Project No. 37107128
October 7, 2010

1.0 INTRODUCTION

1.1 Site Description

Site Name	Six Off-Shore Light Structures
Site Location/Address	Florida Keys, Monroe County, Florida
General Description	#1 – Alligator Reef Light (4 miles east of Indian Key, near Matacumbe Key #2 – Fowey Rocks Light (off Key Biscayne) #3 – Carysfort Reef Light (Carysfort Reef, near Key Largo) #4 – American Shoal Light (Florida Keys) #5 – Sombrero Key Light (near Marathon Key) #6 – Sand Key Light (7 miles southwest of Key West)

1.2 Scope of Work

Infrastructure Engineers collected paint samples down to the iron of the skeletal tower from six off-shore light structures are currently operated by the US Coast Guard at various locations in the Florida Keys, Monroe County, Florida. The approximate location of each light structure is provided in the table above. A photograph taken at the time of sample collection of each light structure is provided in Appendix A.

Infrastructure Engineers collected and delivered a paint sample from each light structure to TestAmerica in Tampa, Florida, a National Environmental Laboratory Accreditation Program (NELAP)-certified laboratory,for total and for toxicity characteristic leaching procedure (TCLP) analysis of the 8 Resource Conservation and Recovery Act (RCRA) Metals (Ag, As, Ba, Cd, Cr, Hg, Pb, Se).

The objective of the sampling and analysis was to evaluate the toxicity characteristic of each paint for the 8 RCRA metals. Terracon Consultants, Inc's (Terracon's) paint testing was conducted in accordance with our Proposal Number P37100246 dated June 22, 2010, authorized by Mr. David R. Reser of Infrastructure Engineers.

1.3 Standard of Care

Terracon's services were performed in a manner consistent with generally accepted practices of the profession undertaken in similar studies in the same geographical area during the same time period. Terracon makes no warranties, either express or implied, regarding the findings, conclusions or recommendations. Please note that Terracon does not warrant the work of laboratories, regulatory agencies or other third parties supplying information used in the preparation of the report. These services were performed in accordance with the scope of work agreed with you, our client, as reflected in our proposal.

1.4 Reliance

This report has been prepared for the exclusive use of Infrastructure Engineers and the United States Coast Guard, and any authorization for use or reliance by any other party (except a governmental entity having jurisdiction over the site) is prohibited without the express written authorization of Infrastructure Engineers and Terracon. Any unauthorized distribution or reuse is at the client's sole risk. Notwithstanding the foregoing, reliance by authorized parties will be subject to the terms, conditions and limitations stated in the proposal, Paint Testing Report, and Terracon's Terms and Conditions. The limitation of liability defined in the terms and conditions is the aggregate limit of Terracon's liability to the client and all relying parties unless otherwise agreed in writing.

2.0 FIELD ACTIVITIES

Infrastructure Engineers' paint chip sampling program involved submitting approximately 105 grams of paint from each light structure for laboratory analysis. Paint chip samples were collected by Infrastructure Engineers from one paint color from each structure as indicated in the table below:

Light Structure	Markings/Pattern	Paint Sampled	Date Sampled
#1 - Alligator Reef Light	black lantern and white framework on black pile foundation	white	6/26/10
#2 - Fowey Rocks Light	black lantern, brown framework with white column	brown	9/09/10

Light Structure	Markings/Pattern	Paint Sampled	Date Sampled
#3 - Carysfort Reef Light	Red with white hatches, shutters and ladder	red	9/10/10
#4 - American Shoal Light	red	red	9/11/10
#5 - Sombrero Key Light	red	red	9/12/10
#6 - Sand Key Light	black framework with white lantern	black	9/13/10

The paint chip samples were collected down to the original metal surface of the structure. Paint chip samples were collected and placed in sealable plastic bags and labeled with indelible marker. The sample bags and completed chain-of-custody forms were relinquished to TestAmerica's analytical laboratory in Tampa, Florida for analysis.

3.0 LABORATORY ANALYTICAL METHODS

The paint chip samples collected from the structure were analyzed for TCLP Extraction and RCRA metals using US Environmental Protection Agency (EPA) SW-846 Method 6010B. The samples were analyzed for mercury by EPA SW-846 Methods 7470A and 7471A.

The executed chain-of-custody form is included in the laboratory report provided in Appendix B.

4.0 DATA EVALUATION

Terracon compared the TCLP Metals concentrations identified in the paint chip samples to the EPA's Maximum Concentrations of Contaminants for Toxicity Characteristic under the Code of Federal Regulations (CFR) 40 CFR §261.24. As shown in the following table, lead in the sample of white paint from Alligator Reef Light and in the brown paint sample at Fowey Rocks Light exceeds the Extraction Procedure Toxicity concentration for classification of a solid waste as a characteristic hazardous waste.

The regulatory level for lead in solid waste is 5.0 milligrams per liter (mg/L) and the laboratory reported a TCLP concentration of 73.8 mg/L of lead at Alligator Light and 132 mg/L of lead at Fowey Rocks Light. In addition, the TCLP concentration of 1.30 mg.L of cadmium at Alligator Reef Light also slightly exceeds the EP Toxicity concentration of 1.0 mg/L for classification of a solid waste as a characteristic hazardous waste.

TOXICITY CHARACTERISTIC LEACHING PROCEDURE CONCENTRATION (mg/L)

METAL	#1 Alligator Reef	#2 Fowey Rocks	#3 Carysfort	#4 American Shoal	#5 Sombrero Key	#6 Sand Key	TOXICITY CHARACTERISTIC
	white	brown	red	red	red	black	
arsenic	0.140	< 0.037	< 0.037	< 0.037	< 0.037	< 0.037	5.0
barium	0.358	0.100	0.108	< 0.060	0.664	0.469	100.0
cadmium	**1.30**	0.021	0.017	< 0.006	< 0.006	0.028	1.0
chromium	< 0.026	0.073	< 0.026	< 0.026	0.116	< 0.026	5.0
lead	**73.8**	**132**	0.163	0.138	2.60	0.199	5.0
selenium	< 0.039	< 0.039	< 0.039	< 0.039	< 0.039	< 0.039	1.0
silver	< 0.028	< 0.028	< 0.028	< 0.028	< 0.028	< 0.028	5.0
mercury	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	0.2

Exterior white paints were and are commonly formulated using lead carbonate. If the area of the Fowey Rocks Light where the paint sample was collected was previously painted white, then it is possible that white paint undercoating(s) could be the source of the elevated TCLP lead concentration in the brown paint sample from Fowey Rocks Light.

Based on information obtained at www.uscg.mil/history/weblighthouses/LHFL.asp, it appears that the following white paints were not sampled during this sampling event:

- American Shoal Light – column previously painted white, now top-coat is painted red
- Sand Key Light – white lantern paint
- Carysfort Reef Light – white paint on hatches, shutters and ladder

Exterior red paints were and are commonly formulated using cadmium sulfide. All of the three red paint samples revealed TCLP cadmium concentrations far below the EP Toxicity concentration.

5.0 FINDINGS AND RECOMMENDATIONS

The findings and recommendations of this investigation are as follows:

- If the white paint at Alligator Reef Light or if the paint at Fowey Rocks Light becomes a solid waste, then it would be classified as a characteristic hazardous waste under Hazardous Waste Code HW D008 (lead) requiring proper disposal, unless there is an exemption that applies. In addition, though not tested during this assessment, if the white paint on the Sand Key Light

lantern, white paint on Carysfort Reef Light, or white paint underlying the red paint at American Shoal Light becomes a solid waste, then it, as well as other possible white paint undercoatings, could potentially be classified as a characteristic hazardous waste requiring proper disposal.

- The analytical results indicate that the paint at Fowey Rocks Light is capable of leaching lead into seawater at the base of the structure through wave action, during rain events or if sanded, ground, scraped, blasted or otherwise abraded. It is unknown if potential white paint undercoating(s) on the brown painted framework could be the source of the lead in the analyzed paint sample; Terracon has no evidence that the framework was previously painted white.

- The white paint at Alligator Reef Light is capable of leaching lead into seawater during rain events or if sanded, ground, scraped, blasted or otherwise abraded.

- Though not tested during this assessment, the white paint on the Sand Key Light lantern may be capable of leaching lead into seawater during rain events or if sanded, ground, scraped, blasted or otherwise abraded.

- Though not tested during this assessment, the white paint on the Carysfort Light hatches, shutters and ladder may be capable of leaching lead into seawater during rain events or if sanded, ground, scraped, blasted or otherwise abraded.

- Though not tested during this assessment, the previously white-painted column at American Shoal Light may be capable of leaching lead into seawater if the white paint underlying the red topcoat is sanded, ground, scraped, blasted or otherwise abraded.

- If the white paint or brown paint is to be disturbed during future repairs or renovation activities, proper procedures should be followed with respect to worker health and safety, and any disturbed white paint or brown paint should be properly handled and/or disposed in accordance with applicable local, state or federal regulations.

- Terracon recommends that the white-painted and brown-painted exterior portions of the structures should be repainted with lead-free paint, unless already done, to encapsulate it and mitigate potential leaching of lead into seawater.

- The black paint and red paint samples were not found to demonstrate characteristic hazardous properties based on the analyses performed. Specifically, cadmium was not measured above the EP Toxicity concentration of 1.0 mg/L in any of the tested red paint samples.